RECENT DEVELOPMENTS IN AUTOMATIC CLEANING OF STORAGE TANKS*

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Automatic cleaning means mechanical cleaning. When successful mechanical cleaning is being done, it is possible, by instrumentation and control, to automatize the cleaning system to any desired degree.

Different ideas seem to exist as to what clean means, as it applies to dairy equipment. In this discussion we mean a tank that is clean, as demanded by all sanitary standards.

Several devices have been used to clean storage tanks by mechanical methods. We should examine these devices and see how each one is supposed to operate.

CLEANING WITH SPRAY BALL

Spray balls have been installed in more storage tanks than any other device. Some have been installed as a permanent part of tank equipment. Others have been designed to be placed in the tank when the cleaning operation is started. Both types of spray balls are expected to do the same cleaning job, so they will be grouped together. These spray balls have been placed on piping extending down from the top of the tanks, on horizontal piping welded to the tank liner and on piping that rests on supports standing on the bottom of the tank. They have generally been self-draining. In fact, they have to be self-draining and self-cleaning if they are to be successful. Some spray balls are made in two sections which are separable and can be taken apart for cleaning. Other spray balls have a plastic ball installed inside, made to bounce around by the solution flow, and keep the inside of the ball clean.

Recently, variations of the spray ball have been designed and installed in storage tanks. Generally they are not spherical in shape, but are supposed to do the same job as the regular spray balls.

The spray balls and variations of them have given varying results. A pump to supply pressure to the cleaning solutions has been attached to the spray ball piping system. These spray balls have been used in all sizes and shapes of tanks. Generally speaking, a single spray ball has been installed for each eight feet of tank length. This has been a general rule and is not true in all cases. They have been placed at different distances from the bottom and from the top of the tanks.

SPRAY UNIT

The second device that has been used is the hot spray unit. This consists of a tank, a hose, nozzle and a pump. A solution is prepared in the tank, and it is heated and sprayed on the tank surface. The hot solution is allowed to remain on the surface for a short time. A respray with the hot solution follows and then rinsing with fresh water as the last treatment. A man must enter the tank to properly apply the cleaning solution.

INJECTOR UNIT

The third cleaning device is the injector type of hot spray unit. This consists of a detergent reservoir tank, a venturi element and a mixing valve with hose and nozzle. The tank is filled with detergent and connected to a water supply. The water flows through the venturi and draws detergent from the supply tank and mixes the solution. The nozzle is then controlled by the man who sprays the surface to be cleaned.

ROTARY SPRAYER

The fourth device is the rotary type sprayer. It has a rotating head, driven by a motor, fitted with a number of spray nozzles. These nozzles are supposed to overlap and completely cover the inside surfaces of the tank. This sprayer requires a pump to circulate the cleaning solution through the spray nozzles.

ROTATING NOZZLE

The fifth device consists of a rotating nozzle equipped head. It is rotated by the jet action of one or more of the spray nozzles. This device has the spray patterns designed to overlap on the tank surface. The rotating mechanism has been made with sleeve type bearings and, more recently, with stainless steel ball bearings. This unit requires a fixed pressure system, to insure positive and constant speed of rotation. Usually, it has been installed in the top of storage tanks. Not many of these cleaning devices have been installed in tanks.

Rotating Hollow Shaft

The sixth cleaning device consists of a rotating hollow shaft that extends down through the top of the storage tank. A fan shaped slotted jet is attached to the hollow shaft. Cleaning solutions, under pressure, flow through the hollow shaft and out through the slotted jet. Because the slotted jet throws a fan shaped pattern of cleaning solution, an uninterrupted stream of solution is placed on the top surface of the tank liner. As the jet assembly rotates, complete coverage of the tank interior is accomplished with each revolution of the jet. Normally, this mechanism rotates five times per minute. This means that five times per minute the entire interior of the tank is covered with cleaning solution.

This rotating slotted jet has also been installed as an integral part of the agitator shaft. It is designed to allow normal use of the agitator without any adjustment. When the cleaning operation is started, solution is pumped through an inlet on top of the tank. The cleaning solution flows through the hollow shaft and out through the slotted jet. This fan shaped pattern of solution covers the upper surfaces to be cleaned and flows down the sides and ends. An opening in the device allows solution to flow down the agitator shaft and thoroughly clean the shaft and upper blade or blades. The bottom agitator blade, or blades, and the bottom bearing are cleaned by rotating in the pool of cleaning solution that collects on the bottom of the tank. This solution is drawn out through the outlet and discharged to the drain or used again.

These devices have been used for cleaning storage tanks, and different ideas exist as to their cleaning efficiency.

Cleaning Procedures

Probably the best way to clean a storage tank by mechanical means would be to proceed as follows:

Fill the tank with water, add the proper chemical to make a good cleaning solution, heat the solution to the proper temperature and shake the tank until the soil is removed from the cleanable surfaces. The only problem is to find a man strong enough to pick up a storage tank and shake it. By accepting this method as the perfect one, we can then consider these mechanical cleaning devices and see how they approach perfection. Certainly, it is safe to assume that good chemicals are available to do the cleaning job. Water and methods of heating are at hand. Pumps, tanks and controls are all presently available. All the different devices can easily be installed in tanks. Now, all that remains is for the mechanical devices to completely cover the surfaces to be cleaned with cleaning solution.

The Spray Ball Method can do this, if it is properly installed and if the proper pressure and volume of cleaning solution is supplied to its inlet. Also provided, and this is very important, that the storage tank has been designed to be cleaned by mechanical means. A four inch diameter spray ball can have any number of holes drilled in its surface, through which the cleaning solution is discharged. To work at all, these balls must be some distance from the surface to be covered. Otherwise, the solution would all strike the surface to be covered in a small area. As the distance increases between the spray ball and the surface to be cleaned, the streams of solution get farther apart. This means that the solution has to bounce or slide across the area between these impact points. It is quite difficult to control this bounce or slide, and again, proper installation should be stressed. If the tank has a Vertical Agitator Shaft, the spray ball has a difficult time in covering the back side of the shaft. It is very hard to cause water to bounce, slide or go around corners, into blind spots, bearings or around any obstructions in the tank. The results from spray ball installations indicate that extreme care must be taken to insure that successful cleaning will result.

The hot spray system of cleaning tanks can do a good job, but it is still a manual operation. It requires the same attention to chemical solution, temperature and time to insure success. This operation also requires that a man go inside the tank and limits its usefulness as a mechanical method of cleaning storage tanks.

The injector system of hot spraying is essentially the same as the pump type system mentioned previously.

It should be mentioned here that some air agitated tanks have been fitted with pumps to force cleaning solution through the air tubes. This was supposed to clean these tanks. I have no information on results obtained by this cleaning method. If complete coverage of the tank interior can be accomplished, this method could be successful.

The rotating head fitted with spray nozzles can be installed in tanks. This device will clean tanks, if it is supplied with the proper chemical solution, under the ideal pressure. This device has limitations. It can't spray around corners or behind shafts. It must be carefully engineered and installed. The nozzles must be adjusted to overlap and completely cover the surface to be cleaned. The problem of being self-draining and sanitary in design must be met. Ordinary pipe threads on the nozzles must be removed and a sanitary connection made. This rotating nozzle equipped head must be carefully installed in a tank to be successful.

The self-rotating cleaning head has the same diffi-
culty in cleaning tanks as do the other devices. Along with these problems are ones inherent in the design of the rotating mechanism. The bearings must be sanitary, self-cleaning and self-draining. Cleaning solutions and the temperature of them affect the operation of this device. Because it is jet operated, pressure affects its speed. This is another device that can clean tanks if all the engineering problems are solved and if it is properly installed in a tank that can be cleaned by mechanical means.

The slotted jet mechanism that is rotated by a separate motor will clean tanks with horizontal agitators or air agitation, if properly installed. The solution comes from the jet near the top of the tank. The jet puts solution on the top surface to be cleaned and into the sight glass and vent openings. The solution flows down the sides of the tank to clean these surfaces. The device requires that a four inch sanitary ferrule be welded into the top of the tank. The mechanism attaches to this ferrule with a four inch sanitary nut. It is self-supporting and the motor is part of the unit. This makes a sanitary, easily inspected device, as the slotted jet comes apart for visual inspection.

The slotted jet device has given perfect cleaning results when installed on a vertical agitator shaft. The tank is cleaned because the slotted jet completely covers the inside of the tank, provided it has been designed to be cleaned by mechanical means.

Care must be exercised that this device is not rotated too fast. At thirty-six R.P.M. the device will clean a tank sixteen feet long. Longer tanks require slower speed agitator motors. Two speed motors have solved this problem.

Some tanks are not made to be cleaned mechanically. It is better to admit this fact and save trouble and misunderstanding when the proper results are not obtained.

From this evaluation of the available mechanical cleaning methods, it is apparent that a good practical method of cleaning storage tanks can be worked out and has been developed to a point where success is assured.

Along with the description of recent cleaning device developments, should go a description of Cleaning Methods as related to chemicals, time, temperature, rinsing, sanitizing and volume of solutions required. Much work has been done along these lines and some practical answers to the questions have been developed.

We have found that a good pre-rinse with tempered water does the best job of removing the loose soil in storage tanks. This temperature range is ninety to one hundred-ten degrees F. Applying three-tenths of a gallon to each square foot of tank surface will result in a good pre-rinse job. This figure is correct when a slotted fan shaped jet was used. A good practical way of deciding on the amount of pre-rinse water to use is to observe the rinse water as it leaves the tank outlet. When it is clear, the tank can be considered to be adequately rinsed.

We recommend that the advice of the Chemical Supplier be followed. These people know their products and what they will do. They have the materials to properly clean these tanks by mechanical means, so they should be consulted in their use. The strength of the solution must be strong enough to remove the soil in the tank. Too much chemical only results in waste. We feel that the solution temperature should be kept as low as possible. However, the chemical in question may require a minimum temperature, so you have to follow its recommendations. Remember that heat causes the stainless steel to expand, cold causes it to contract. These forces should be held in check. Results have proven that cleaning can be accomplished by a maximum solution temperature of one hundred thirty-five degrees F. The slotted jet delivering fifty g.p.m. to the interior surfaces of the tank, will clean a two thousand gallon storage tank in ten minutes.

A cooling fresh water rinse should be applied after the cleaning solution treatment. This removes all traces of the solution and cools the tank surfaces. Good rinsing is essential to good cleaning.

Mechanical cleaning to be successful depends on these things. Complete coverage of the surfaces to be cleaned, with a chemical solution of the proper concentration, heated to and maintained at the proper temperature. The solution must be kept in contact with the tank surfaces for the prescribed length of time. Coverage, time, temperature and solution concentration are the things necessary to assure clean tanks.

An important side effect to consider when cleaning storage tanks, is the cooling system on the individual tank. Hot solutions contacting the refrigerated zone can cause much grief, if the proper precautions are not followed. It is essential that a refrigeration engineer be consulted before proceeding with mechanical cleaning.

From developments up to this time it is apparent that we can clean storage tanks by mechanical means. The system can be automatized to any desired degree. Installing an automatic circulation cleaning system insures that time, temperature and solution concentration are maintained. Installing flow diversion valves in the lines to and from the tanks to be cleaned and applying controls and indicators to them will make a system push button in operation.

In other words, pushing button number one would clean tank number one automatically. All precautions would be observed by the control system. If
the tank wasn’t empty, a control would not allow the cleaning operation to begin. Anything desired can be built into the automatic system.

These recent developments have indicated that a practical method of cleaning tanks mechanically has been developed to the point where success is assured.

These developments have proven that steps are being taken to make mechanical cleaning more easily acceptable by the industry. The biggest step is to build storage tanks with mechanical cleaning in mind.

This requires some head scratching by the designers and means that we all have to change our ideas about the inside of the storage tank. It is very difficult to apply a good mechanical cleaning device to a tank built years ago for hand cleaning.

The outlet of the storage tank can generally be cleaned mechanically. The manhole, door and gasket on most tanks have to be washed by hand. This is true when mechanical cleaners are used. The sight glass opening on most tanks has to be removed and hand washed. The product inlet and air vent openings are a hand washing job. The test valve must be hand cleaned. The measuring device on the tank must be hand cleaned. The agitator bearing must be cleaned by hand. From this list of hand cleaned parts and fittings, it is apparent that consideration must be given to redesign. The parts mentioned above should be redesigned to permit mechanical cleaning.

It is possible to build a storage tank now so that these parts could be cleaned mechanically. The problems of how to work around the parts that must be hand cleaned are solved.

Suppose the manhole and the door were moved to the top of the tank. Now the door is only used for inspection and could be much lighter and would be out of the product zone. The air vent would be placed on this door. The product inlet can be in this door, or in many cases, the product can enter the tank through the outlet valve. This method would remove the product inlet and its cleaning problem. A practical method of measuring the volume of liquid in the tank is available. Known as the bubble system, it only requires a small sanitary C.I.P. fitting on the bottom of the tank. The indicating thermometer fitting is no problem. The test cock may have to be cleaned by hand, if it is necessary to have one on the tank. If a sightglass is necessary, it can be of the new flush mounted C.I.P. type that is readily cleanable. The vertical agitator has the cleaning device mounted as an integral part. This agitator is self-cleaning and its support bearing is also self-cleaning.

When tanks are built along these lines, mechanical cleaning will be easy and guaranteed results will be obtained.

The cleaning devices are developed and are practical. Now remains the problem of building storage tanks to take advantage of these labor-saving methods.